Calawah River watershed –

The Calawah River is a large tributary to the Bogachiel River, with the outlet located just downstream of Forks near Bogachiel river mile 8. The Soleduck River watershed confines the Calawah watershed on the north, east, and west, and the Bogachiel River watershed lies adjacent to the south. Figure 13 illustrates the location of the Calawah River watershed within WRIA 20 and the Quillayute River watershed.

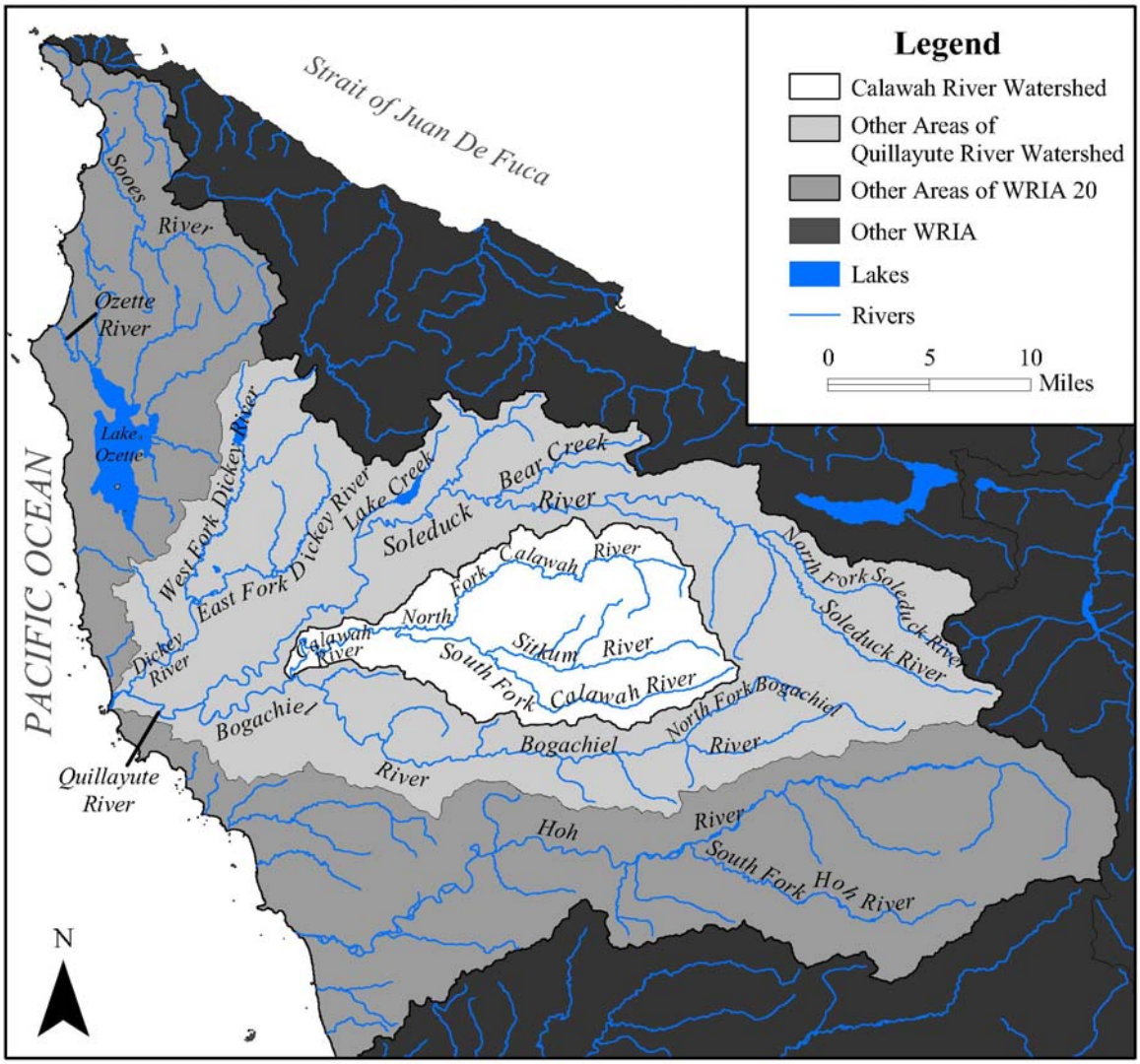

Figure 13. Location of Calawah River watershed.

The Calawah River watershed covers approximately 136 square-miles. Elevations range from less than 100 ft at the mouth to over 3400 ft. Precipitation is extremely high over the entire watershed with average precipitation ranging from 95 inches to over 125 inches annually. Precipitation levels are the lowest

along the northeastern boundary near Bigler Mountain and Grindstone Pass and highest along southwestern border near Elk Ridge. The movement of weather patterns through the area is anticipated to be from the southwest towards the northeast, thus the indicated areas of high and low precipitation are expected.

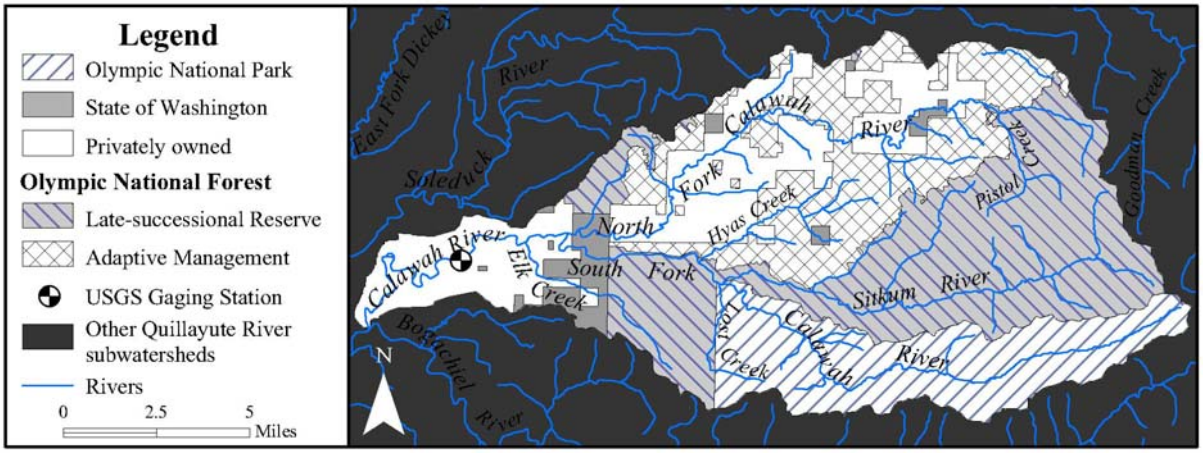

Figure 14. Land Administration within the Calawah River watershed.

The Calawah River is separated into a north and south fork about 10 miles upstream of the watershed mouth. The largest tributary within the Calawah River drainage beyond these two forks is the Sitkum River. The Calawah River headwaters begin in the Olympic National Forest and the Olympic National Park and flow west. Table 20 summarizes the land ownership within the entire Calawah River watershed.

Table 20. Land Administration within the Calawah River watershed.

Land Owner/Administrator	Area (sq. mi.)	Percent of Total Area
Olympic National Park	25.9	19.0
Late-successional Reserve (USFS)	48.6	35.7
Adaptive Management (USFS)	27.7	20.4
State of Washington	4.7	3.5
Privately owned	29.1	21.4
Total Area	136.1	100

The areas managed by the USDA Forest Service are subject to the President's Northwest Forest Plan of 1994. In this plan, Forest Service and some state and private in-holding lands have been assigned specific management designations, if outside of a wilderness area. No wilderness areas exist within the Calawah River watershed, other than the land within the Olympic National Park, which covers less than one-quarter of the watershed. Over one-third of the entire watershed has been designated Late-successional Reserve through the Northwest Forest Plan,

where the goal is to maintain or develop 'old-growth-like' conditions. The remaining Forest Service lands, which total about another 20 percent of the watershed, have been designated an Adaptive Management area where the land is managed to provide both ecological and economic benefits. Private entities manage almost one-quarter of the watershed, mainly near Forks.

Over the last 100 years, timber removal has occurred over the majority of the watershed. Today, the majority of the Calawah River watershed is forested. The majority of land within the Calawah River drainage above the North Fork and South Fork confluence was inventoried during a Forest Service analysis of timber age class, and the resultant GIS coverage provided the information provided in Table 21 (ONF, 2000). This inventory assessed timber age classes in the areas managed by the Forest Service and the State of Washington above the North Fork and South Fork Calawah River confluence. Old-growth conditions can also be found in the Olympic National Park to the south of the Sitkum River drainage, which was not included in the age class inventory by the Forest Service. If we assume the timber within the Olympic National Park are at least over 81 years old, then timber over 81 years of age covers at least 62.4 square-miles or 52 percent of the entire area above the North Fork and South Fork Calawah River confluence, which measures 120.2 square-miles in area. Also, the amount of timber that is over 41 years of age covers at least 102.9 square miles or 85.6 percent of the entire area above the North Fork and South Fork Calawah River confluence. Keep in mind that some privately owned areas above this confluence were not included in this timber inventory, so there is the potential for each age group classes to increase if any old timber exists on these private lands.

Table 21. Age class descriptions of part of the timber located above the North Fork and South Fork Confluence within the Calawah River watershed.

Age Class Designated by USDA Forest Service	Area (sq. mi.)	Percent of Total Area
0 - 20 years	7.05	7.4
21 - 40 years	11.8	12.3
41 - 60 years	38.9	40.5
61 - 80 years	1.62	1.7
81 - 160 years	3.44	3.6
over 160 years	33.1	34.5
Total Area	95.9	100

The Calawah River USGS gage is located approximately 3.6 river miles downstream of the North Fork and South Fork Calawah River confluence. Although we know little about the additional privately owned and state managed lands between this confluence and the gage location, the 102.7 square-miles of timber that have been identified as older than 41 years of age still represent a significant portion, or 78 percent, of the 131.1 square miles contributing to

streamflow at the gaged location. The USGS also indicated that no diversions occur upstream of the gage in their gage summary. As such, the USGS gaging station 12043000 was considered to represent undepleted or natural streamflow conditions in the Calawah River.

Both the Sitkum and the South Fork Calawah subwatersheds contain the highest elevation headwaters, particularly Pine Mountain within the South Fork drainage. These higher elevation subwatersheds have ridges that exceed 3400 ft, and several subwatershed areas that span areas entirely above 2500 ft are characterized as highland subwatersheds. These subwatersheds typically experience higher snowfall accumulations that remain into the spring and summer months. At elevations below 2500 ft, winter snow accumulation may not remain for many months; rather snowmelt occurs within a week or so of accumulation.

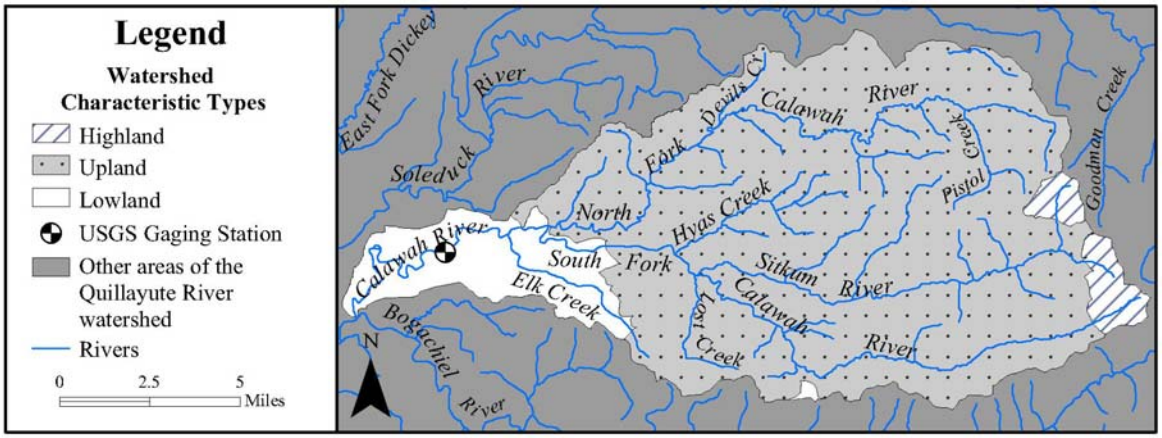

Figure 15. Watershed Characteristics of the Calawah River watershed.

The flow of the Calawah River is fed by subwatershed areas that exhibit specific characteristics, as shown in Figure 15. The highland subwatersheds are located at the headwaters of the Calawah River. These areas are characterized by the snowmelt runoff that lasts until late summer, but only a small portion of the entire watershed, less than four percent, exhibits these characteristics as seen in Table 22 below. The largest subwatershed type contributing to flow in the Calawah River is a large upland subwatershed. These areas correspond to those below 2500 ft, which experience only short term snow accumulation. Upland subwatersheds tend to cause an increase in streamflow during the winter-season precipitation months due to snowmelt runoff. Almost 90 percent of the entire watershed is characterized as upland subwatershed, but over five percent of that area is ineffective due to flat slopes. In these areas, recharge to surficial aquifers is likely to occur and minimal runoff from these areas contributes to streamflow. Two specific areas adjacent to the North Fork Calawah River are considered upland yet ineffective towards streamflow, the Cooper Ranch Valley and areas south of Bonidu Creek. The lowest elevation areas are characterized as lowland subwatersheds. Lowland areas contribute to streamflow in a similar fashion as

the upland areas by providing additional streamflow during winter precipitation months. These areas also usually allow summer streamflow to recharge surficial aquifers, thereby reducing streamflow. Several lowland areas within the Calawah River watershed are considered ineffective areas. The majority of lowland areas are considered to produce insignificant additional streamflow under natural conditions, since the land in these areas is extremely flat, particularly near Forks. Also, these areas are not considered to reduce summer streamflow significantly, particularly those that are not located adjacent to the stream channel.

Table 22. Watershed Characteristics of Areas within the Calawah River watershed.

Watershed Characteristics	Area (sq. mi.)	Percent of Total Area
Highland	4.7	3.4
Upland	107.7	79.2
Upland, *but ineffective*	8.0	5.9
Lowland	7.0	5.1
Lowland, *but ineffective*	8.7	6.4
Total Area	136.1	100

Streamflow Evaluations of the Calawah River

A USGS gaging station 12043000 is located on the Calawah River at RM 6.5, where Highway 101 crosses the river near Forks. The effects of land management activities on this gage is considered to be minimal under current conditions for the reasons discussed previously. Daily gaged streamflow records are available for this gage intermittently between January 1976 and September 1983 and continuously starting in March 1984. This gage is still in operation.

The available gaged streamflow records between 1976 and 2000 were extended to create an complete period of record between October 1961 and September 2000. An extended streamflow record was created for this gage using regression techniques against two nearby streamflow gages that had overlapping periods of record with the Calawah River gage. These gages are:

- USGS Station Number 12042800 Bogachiel River near Forks, WA
- USGS Station Number 12043100 Dickey River near La Push, WA

As described previously for the Bogachiel River, regressions against these gages were completed using all monthly total values in the same regression equation, whereas regression equations based on each month were developed for gages with a greater number of coincidental months. These equations exhibited excellent similarities to the Calawah River gage (R^2 values of 0.984 against the Bogachiel

River gage and 0.972 against the Dickey River gage), streamflow information was not collected at any of these gages for several months in the desired period of record between October 1961 and September 1999. For these remaining 69 months, which represents approximately 15 percent of the entire period of record, monthly total streamflow was estimated for the Calawah River gage from an extended period of record developed for USGS gaging station 12043300, Hoko River near Sekiu, WA. This Hoko River gage was extended using total monthly precipitation values from precipitation stations in Sappho, Clallam Bay, Forks, and Neah Bay.

Streamflow for the Calawah River and its tributaries was estimated and evaluated at 4 primary locations within the watershed. The three largest subwatersheds within the Calawah River drainage are the North Fork Calawah River, the South Fork Calawah River, and the Sitkum River. A complete period of record between October 1961 and September 1999 was developed immediately above the confluences between these subwatersheds. These locations can be seen in Figure 16 below. The streamflow below these confluences can be considered equal to the sum of the two contributing streams.

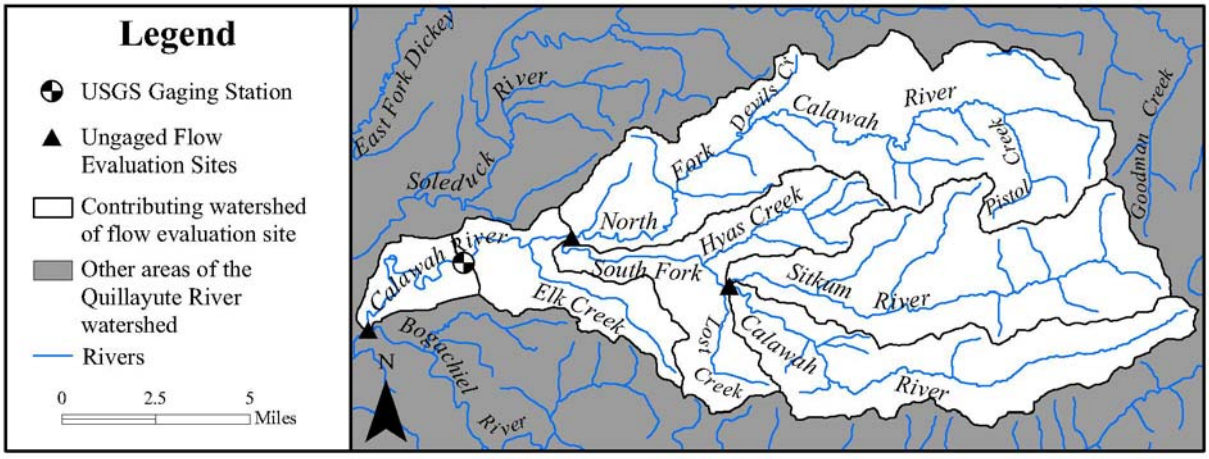

Figure 16. Locations within the Calawah River watershed where natural flows were developed.

Streamflow was estimated at ungaged locations using the watershed characteristics method, which is described in Appendix 1. Representative type-watershed flow histories were generated for highland, upland, and lowland areas through by comparing streamflow records and watershed characteristics for the contributing watershed above the USGS gaging station 12042800 Bogachiel River near Forks, WA. The watershed characteristic information for the Calawah River watershed is provided below. Table 23 and Table 24 summarize the area and average annual precipitation values used in the watershed characteristics method to develop streamflow estimates for each Calawah River subwatershed.

Table 23. Watershed characteristics within each portion of the Calawah River watershed.

Watershed Characteristic Types	South Fork Calawah River above Sitkum River confluence	Sitkum River above South Fork Calawah River confluence	South Fork Calawah River above NF Calawah River confluence	North Fork Calawah River above SF Calawah River confluence	Calawah River at gage # 12043000 - Calawah River nr Forks	Calawah River at Outlet
	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)	Area (sq. mi.)
Highland	1.58	3.09	-	-	-	-
Upland	21.6	27.8	16.5	39.8	2.09	-
Upland-*ineffective*	-	-	0.013	7.98	-	-
Lowland	-	-	1.13	-	4.63	1.23
Lowland-*ineffective*	0.24	-	0.57	-	4.18	3.70
Entire area	23.4	30.8	18.2	47.8	10.9	4.93

Table 24. Average annual precipitation for each portion of the Calawah River watershed.

Watershed Characteristic Types	South Fork Calawah River above Sitkum River confluence	Sitkum River above South Fork Calawah River confluence	South Fork Calawah River above NF Calawah River confluence	North Fork Calawah River above SF Calawah River confluence	Calawah River at gage # 12043000 - Calawah River nr Forks	Calawah River at Outlet
	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)	Average Annual Precip (in.)
Highland	121.3	111.9	-	-	-	-
Upland	119.4	114.8	122.7	112.3	123.5	-
Upland-*ineffective*	-	-	124.3	104.0	-	-
Lowland	-	-	122.2	-	120.3	104.0
Lowland-*ineffective*	122.5	-	122.2	-	114.8	104.0
Entire area	119.5	114.5	122.7	110.9	118.8	104.0

The evaluation of streamflow at each location is described below. The following section describes and illustrates the expected range in streamflow variation for each location in average monthly streamflow in cubic feet per second (cfs).

South Fork Calawah River above Sitkum River –

The South Fork Calawah River is separated from the Sitkum River by Rugged Ridge. This area above Sitkum River includes flow developed in highland and upland subwatershed areas, which begins along the western flanks of Pine Mountain. The drainage area of the South Fork Calawah River above this confluence measures 23.4 square-miles, of which seven percent is highland subwatershed and 92 percent is upland subwatershed. The remaining one percent is the area associated with Indian Pass, located along the southern watershed boundary, and is considered typical of lowland subwatersheds, but ineffective toward streamflow due the slope of land.

Seasonal maxima in streamflow are clearly shown for the winter season precipitation maximum. During the late summer and into the fall, flow in the South Fork Calawah River recedes to minimum flow. This minimum flow season is indicated to extend into September. The months between November and February exhibit the greatest indicated variation in streamflow.

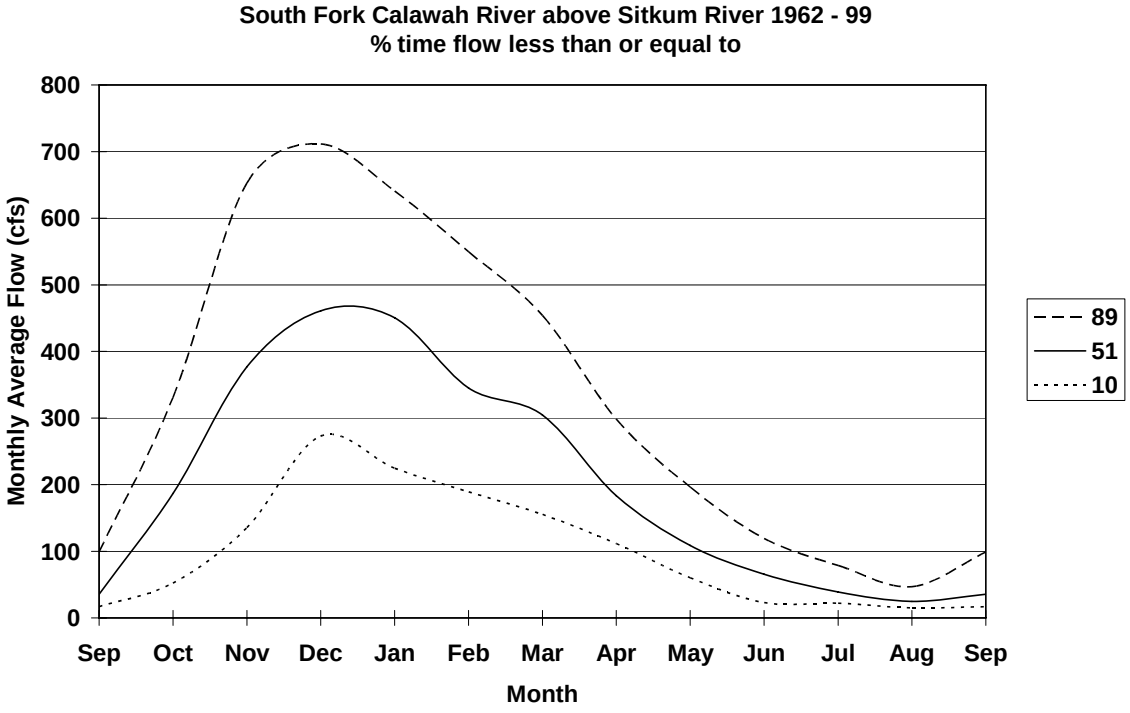

Table 25. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month at the SF Calawah River above the Sitkum River.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	331	653	711	641	550	454	298	196	119	79	47	99
51	187	377	461	451	345	304	183	109	66	39	25	35
10	52	136	273	224	189	155	112	60	23	22	15	17

Sitkum River at the Outlet –

The Sitkum River is located to the north of the South Fork Calawah River drainage and south of the North Fork Calawah drainage. Streamflow at the outlet is comprised of several subwatersheds, North Fork Sitkum River, Rainbow Creek, and the Upper Sitkum River. These areas and the intermediary catchments measure almost 31 square-miles in area. Of this entire area, only 10 percent is characterized as highland subwatershed, while 90 percent is typical upland subwatershed. The entire Sitkum River watershed contributes directly to streamflow through runoff, thus there are no ineffective areas.

Winter-season precipitation dominates the Sitkum River hydrograph, as seen in the illustrated range of flow below. The large increase of streamflow during the winter months relates to snow accumulation that lasts only about a week or so before melting. This range in flow is similar to that of the South Fork Calawah River, but has greater variation in winter due to a larger contributing drainage area. The months noted with the largest variation in streamflow are between November and January.

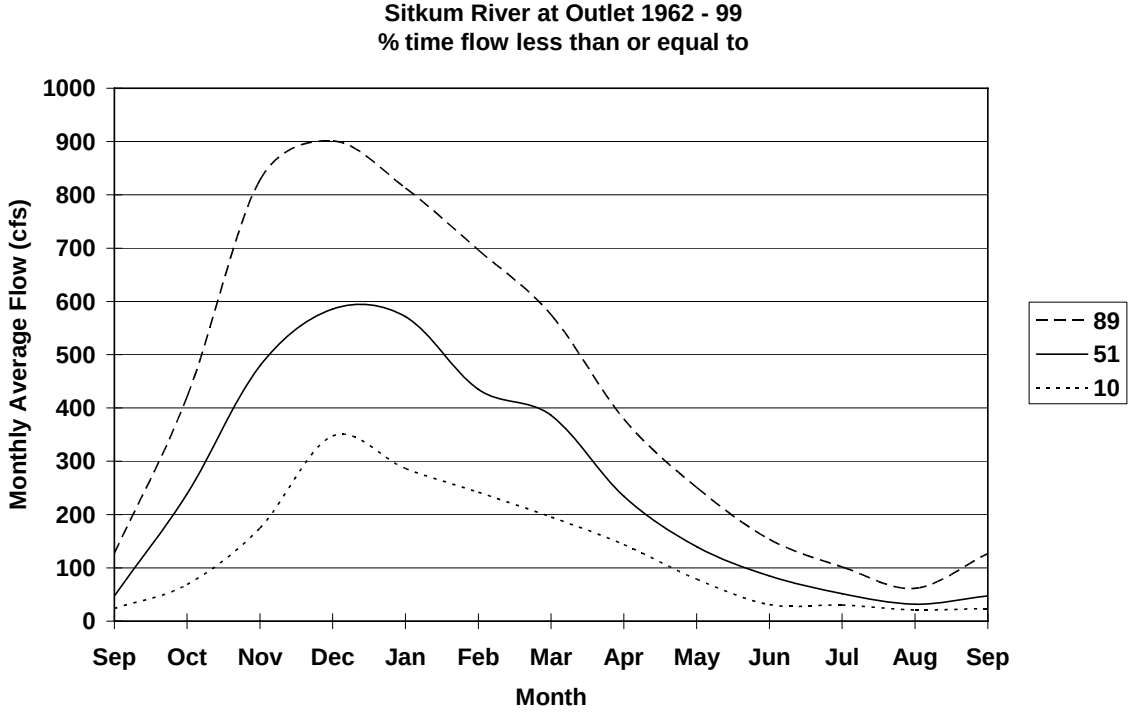

Table 26. The percent of time that average monthly streamflow (cfs) is less than or equal to the indicated value for each month in the Sitkum River at the outlet.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	421	828	901	813	696	575	380	251	153	102	62	127
51	239	479	586	572	435	386	234	140	85	52	32	48
10	69	175	348	286	242	195	144	79	31	30	21	24

South Fork Calawah River at the Outlet –

Two significant tributaries contribute to flow in the South Fork Calawah River below the Sitkum River confluence. Lost Creek joins the main stream channel just a few hundred feet downstream of the Sitkum River, and the Hyas Creek confluence is located less than a mile downstream of there. At the outlet, the entire contributing area of the South Fork Calawah River is 72.4 square-miles. Lost Creek and Hyas Creek are both entirely typical of upland subwatershed areas, as well are most intermediary areas. The furthest downstream stretch of the river, mainly west of Klahanie Campground, is considered lowland subwatershed. Within this area, land slopes decrease and a small area is ineffective toward streamflow. Only slightly over one percent of the entire watershed is considered ineffective toward runoff.

The greatest variation in South Fork Calawah streamflow occurs in the winter, specifically between November and February, as is expected of the upland subwatersheds that dominate the drainage area. Streamflow decreases down to minimum baseflow levels in August and September.

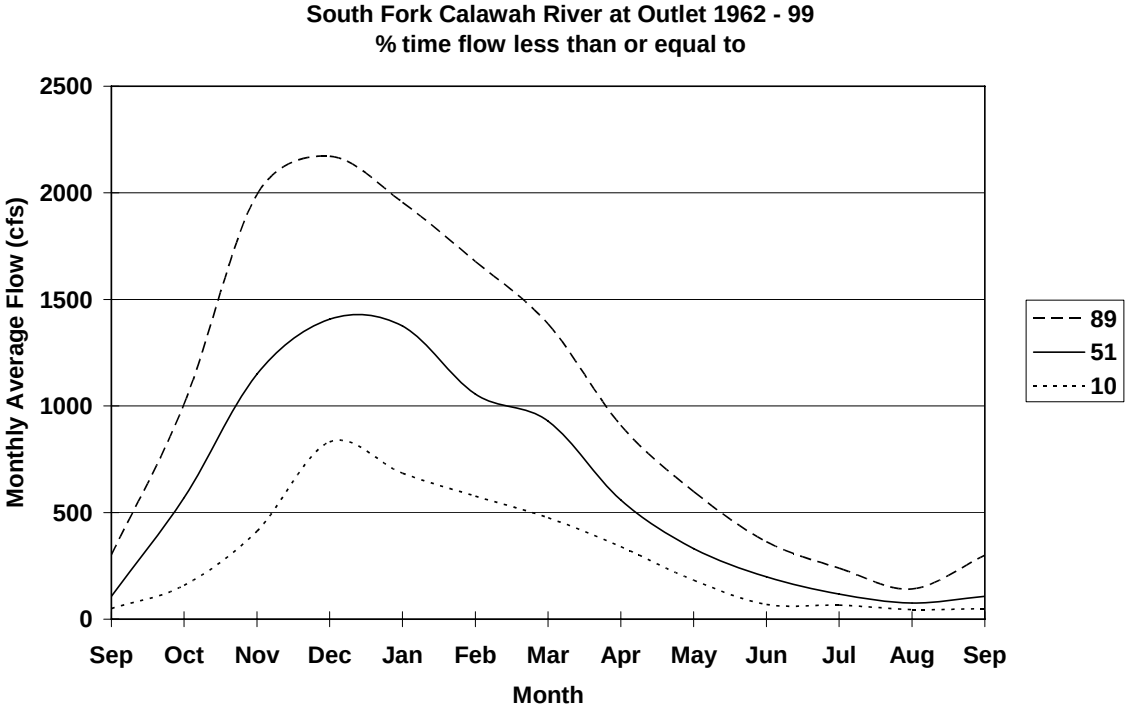

Table 27. The percent of time that average monthly streamflow (cfs) in the South Fork Calawah River at the outlet is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1008	1992	2172	1956	1678	1385	909	598	363	239	142	300
51	570	1150	1406	1375	1056	929	559	331	199	117	76	107
10	158	412	832	684	577	475	340	182	69	66	45	50

North Fork Calawah River at the Outlet –

The North Fork Calawah River watershed is located north of the Sitkum River watershed and includes the large tributaries of Pistol Creek, Bonidu Creek, Albion Creek, Canyon Creek, Devils Creek, Fahnestock Creek, and Cool Creek. The entire watershed covers only 47.7 square miles in area, of which over 83 percent is characterized as upland subwatershed. The remaining 16.7 percent is also upland subwatersheds, but this area is ineffective towards streamflow under natural conditions due to large areas that are flat in slope. Specifically, the majority of the Cooper Ranch Valley is considered ineffective towards streamflow, but the steeper sloped areas on the valley walls would capture a portion of flow during high precipitation events and thus is considered effective. The other large ineffective area is located south of Bonidu Creek. North Fork Calawah streamflow is dominated by the winter-season precipitation. Since there are no highland subwatershed areas, the summer baseflow levels are lower than those of the South Fork Calawah River with minimum flows averaging between 5 and 20 cfs over the months of August and September. The months of greatest variation in streamflow are between November and January.

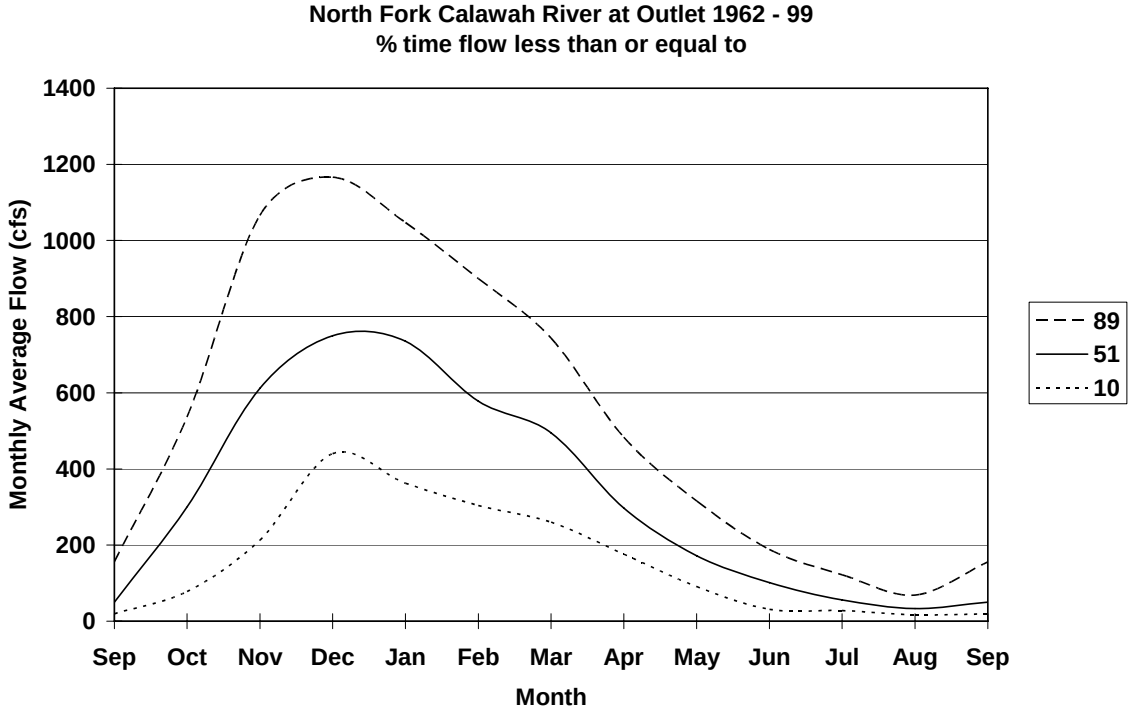

Table 28. The percent of time that average monthly streamflow (cfs) in the North Fork Calawah River at the outlet is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	536	1066	1166	1047	900	743	483	316	188	122	69	155
51	300	612	750	736	578	495	297	172	101	56	33	50
10	78	213	440	362	304	260	176	91	31	28	17	19

Calawah River near Forks (at USGS gage 12043000) –

As discussed previously, the USGS gaging station 12043000 has a fairly complete period of record and is still in operation today. Elk Creek is the last large tributary in the Calawah River and outflows 1.2 miles downstream of the North Fork and South Fork confluence. The area below this confluence down to the Calawah River outlet is called the Forks Prairie. The city of Forks is located in this area. A large portion of the Forks Prairie is considered ineffective towards streamflow because precipitation in these flat areas is most likely lost to interception or surficial groundwater aquifers that would not influence surface water streamflow gaging. The contributing area above the gage location measures 131.1 square-miles in area, of which over 82 percent is characterized as effective upland subwatershed. The months of greatest streamflow variation at USGS gaging station 12043000 are between November and January. Peak average monthly streamflow can reach over 4000 cfs during these months, and minimum baseflow levels average between 45 and 75 cfs in the months of August and September.

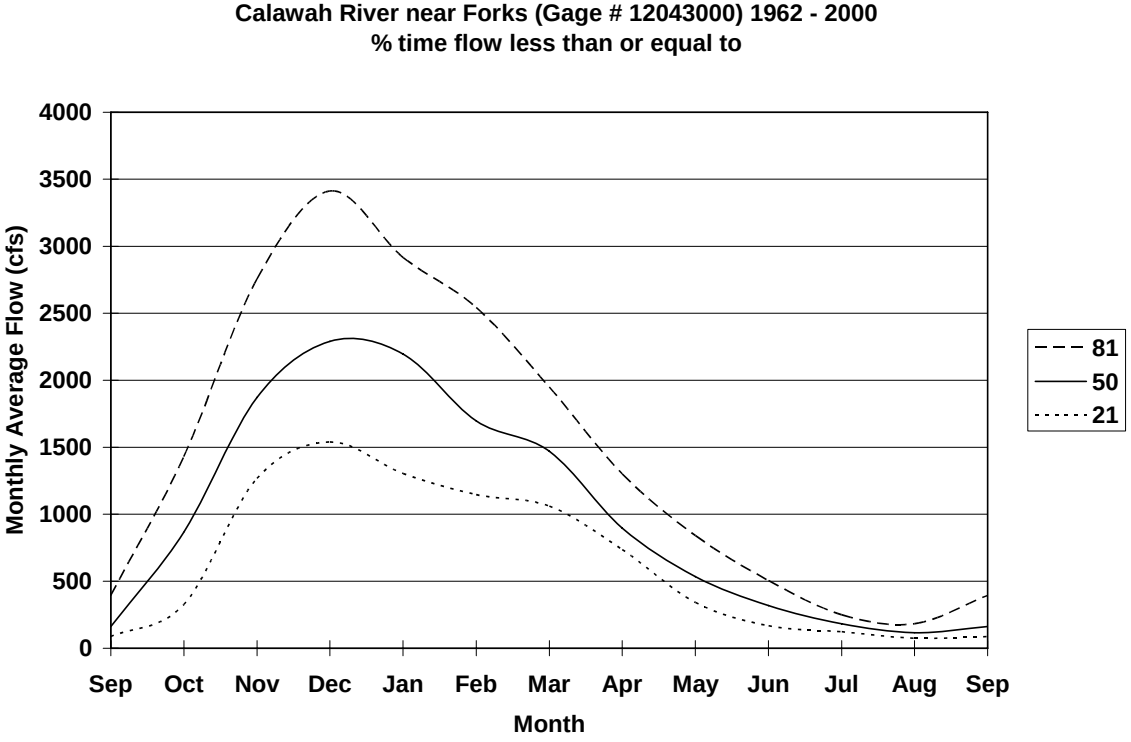

Table 29. The percent of time that average monthly streamflow (cfs) in the Calawah River at the Forks gage is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1640	3249	3557	3190	2739	2262	1479	970	604	382	223	483
50	867	1871	2291	2195	1697	1469	896	534	318	183	115	161
10	249	663	1351	1111	935	781	547	289	105	99	65	72

Calawah River at the Outlet –

Streamflow at the outlet of the Calawah River is quite similar to that measured at the USGS gaging station. Streamflow at the outlet of the Calawah River was estimated by adding gains in streamflow to flow measured at the upstream gage location. Only a small increase in streamflow can be seen between the gage and the outlet at low flow conditions while a large increase occurs at times of higher flows. Similar to the upstream gage, the months of greatest streamflow variation are between November and January and baseflow levels occur in August and September.

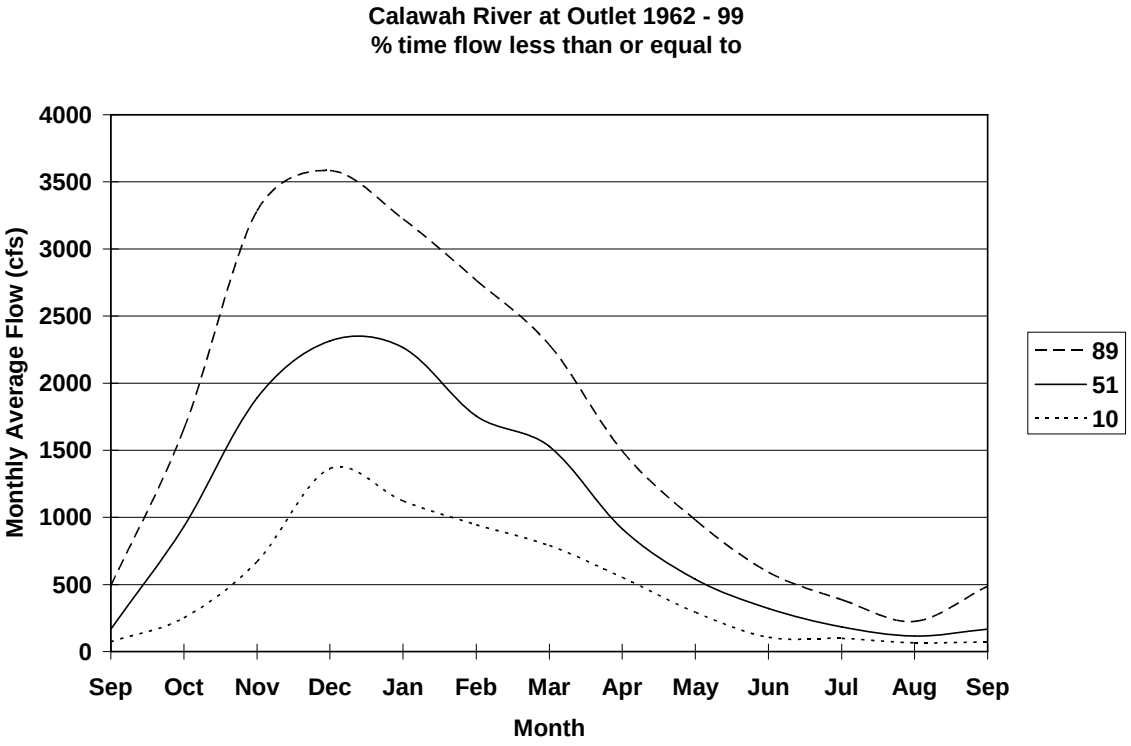

Table 30. The percent of time that average monthly streamflow (cfs) in the Calawah River at the outlet is less than or equal to the indicated value.

Percent	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
89	1657	3283	3584	3224	2767	2285	1494	980	591	386	225	488
51	933	1891	2315	2266	1755	1529	915	539	322	184	116	168
10	252	670	1364	1123	945	790	552	292	106	100	66	73